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FLOOD INSURANCE STUDY

ORIGINAL

COMPLETED

CITY OF FULTON, MISSOURI

CALLAWAY COUNTY

MAY 15, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 290051

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Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

CITY OF FULTON,
CALLAWAY COUNTY,
MISSOURI

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Type 19 Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Fulton, Callaway County, Missouri, and to aid in the administration of the Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to revise the Flood Insurance Rate Map developed from data presented in the Type 15 Flood Insurance Study. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgements

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the Type 15 Flood Insurance Study were performed in 1981 by the U.S. Army Corps of Engineers (COE), Kansas City District (the Study Contractor), for the Federal Emergency Management Agency (FEMA) under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 25, and covered all significant flooding sources affecting the City of Fulton. Under Contract Amendment No. 5, the study was updated in September 1983 to include the effects of the William Woods College Dam and Industrial Drive bridge on Smith Branch and the Bluff Street bridge on Stinson Creek; to add detailed flooding on Dunlap Creek; and to include the effects of a new culvert on Big Hollow Creek. All other detailed study information was taken from the Type 15 Flood Insurance Study for the City of Fulton (Reference 1).

1.3 Coordination

Community base map selection and the identification of streams requiring detailed study for the Type 15 Flood Insurance Study were conducted in meetings attended by representatives of the Study Contractor, FEMA, and the City of Fulton on December 21, 1977.

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During the course of the work by the Study Contractor, flood elevations, flood boundaries, and floodway delineations on the Type 15 Flood Insurance Study were reviewed with community officials on April 21, 1981.

In February 1985, the results of the Type 19 Flood Insurance Study were reviewed and accepted by representatives of the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Fulton, Callaway County, Missouri. The area of study is shown on the Vicinity Map (Figure 1).

The following streams were studied in detail:

a. Stinson Creek, within the corporate limits;

b. Smith Branch, from its mouth at Stinson Creek to about 0.7 mile upstream of Westminster Avenue;

c. Whitlow Branch, from its mouth at Stinson Creek to about 940 feet upstream of East Reed Street;

d. Westminster Branch, from its confluence with Stinson Creek to about 1,400 feet upstream of Parkview Avenue;

e. Big Hollow Creek, within the corporate limits; and

f. Dunlap Creek, from just upstream of Old Harring Mill Road to about 1.39 miles upstream of Old Harring Mill Road.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through September 1988. The scope of methods of study were proposed to and agreed upon by FEMA and the City of Fulton.

2.2 Community Description

The City of Fulton, located near the center of Missouri, is approximately 19 miles southeast of Columbia and approximately 20 miles northeast of Jefferson City. Fulton, the county seat of Callaway County, is completely surrounded by the unincorporated areas of the county. Fulton is the host city of two colleges: Westminster and William Woods. Churchill Memorial Church, which was originally constructed in England, is now located on the campus of Westminster College. The population of Fulton was reported to be 11,046 in 1980 (Reference 2).

The climate of Fulton is representative of central Missouri. The average temperature ranges from a high of 81 degrees Fahrenheit (F.) in July to a low of 28 degrees F. in January. The average annual precipitation is 37 inches for the area near Fulton (Reference 3).

The terrain within the corporate limits of Fulton is dissected by the above-named streams. Land surface elevations vary from 860 feet National

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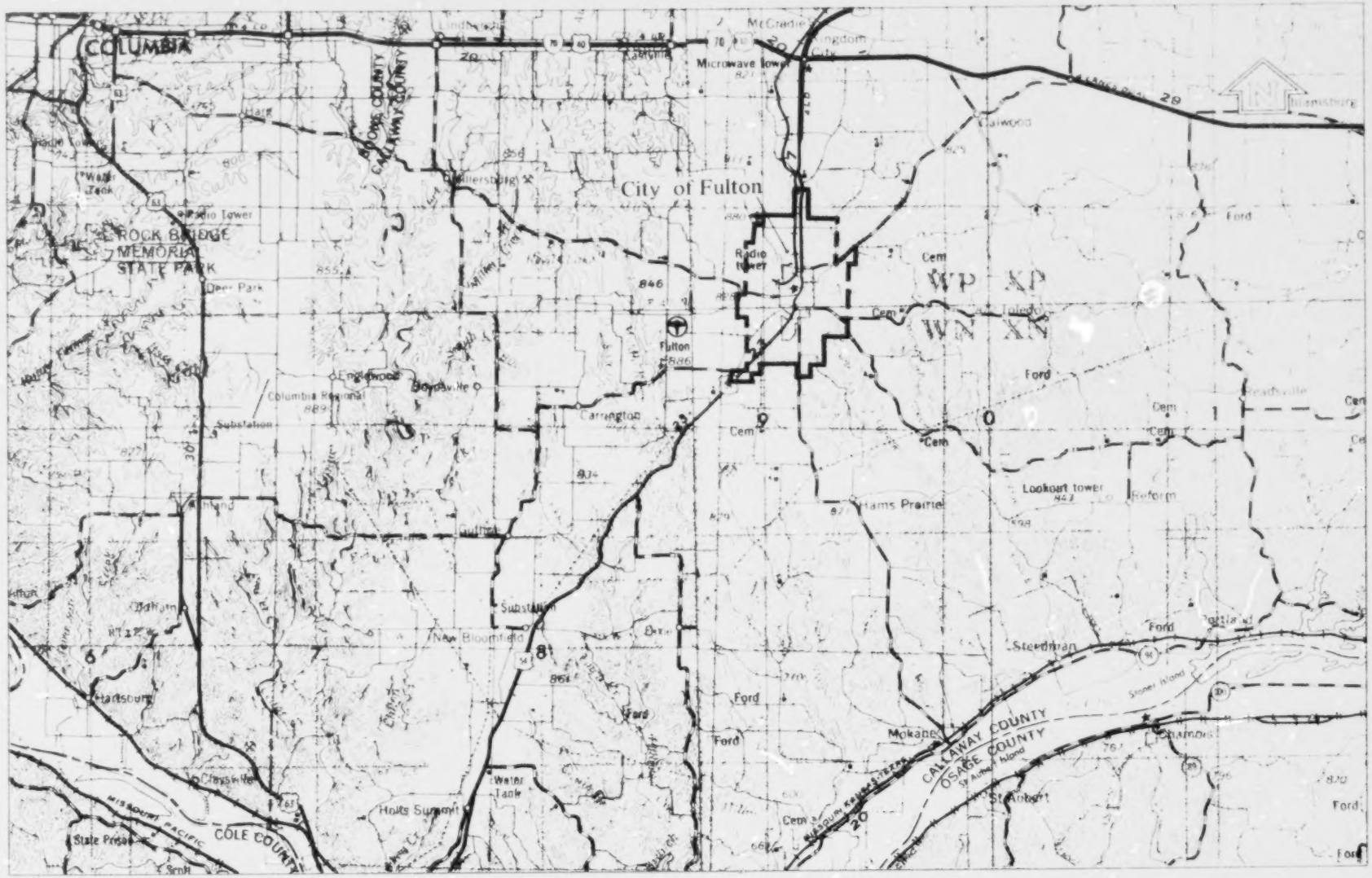

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO

(CALLAWAY CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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Geodetic Vertical Datum of 1929 (NGVD) at the northwestern corner, to an elevation of 700 feet NGVD near the southeastern corner of the corporate limits.

Soils in the area are gently sloping to steep, and moderately drained to excessively well-drained. These soils are composed of cherty, loamy, clayey upland soils of the Hatton, Kleewan, Goss, and Gasconade classes (Reference 4).

2.3 Principal Flood Problems

The areas adjacent to the streams within the corporate limits of Fulton are all subject to floodflow from runoff occurring as a result of intensive rainfall. The shape of the basin, the pattern of the drainage system, and the topographical conditions are contributing factors toward rapid concentration of runoff into flood-producing discharges.

Heavy timber and brush growing in many places on the flood plains of each of the streams studied form a natural obstruction to floodflows. The slower velocities in these areas force the water level higher and increase the lateral extent attained by the flood.

Manmade obstructions further compound the flood problem. The bridges and culverts along the streams severely restrict the flow capacity of the streams during periods of high water by reducing the available area of flow for floodwaters. Debris collecting at bridges and culverts restricts the flow area even more. Debris may also collect on fences spanning the streams.

These obstructions, both natural and manmade, cause a damming effect on floodwaters, thus creating a rise in the water surface immediately upstream of the constriction. Downstream of the constriction, the velocity of flow is sometimes increased drastically, which can cause severe erosion problems. Flood damage records for these streams are limited.

2.4 Flood Protection Measures

A series of levees on Stinson Creek that surround a sewage treatment plant and disposal pond exist in the study area and provide the community with some degree of protection against flooding. However, it has been ascertained that these levees do not protect the community. The criteria used to evaluate protection against the 100-year flood are 1) adequate design, including freeboard, 2) structural stability, and 3) proper operation and maintenance. Levees that do not protect against the 100-year flood are not considered in the hydraulic analysis of the 100-year flood plain.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance,

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respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community.

Basin modeling techniques of the Environmental Protection Agency (EPA) Stormwater Management Model (Reference 5) were used to compute the peak discharges for all streams studied. The EPA model determined discharges by developing a storm hydrograph from rainfall intensity data. The EPA model took into consideration the amount of infiltration and detention storage before estimating discharges. Changes and additions to the model were made by the COE to reflect watershed flow conditions.

A decrease in discharges occurs on Whitlow Branch downstream of Mokane Road, due to the containment of floodwaters upstream of the Mokane Road bridge.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals.

Cross sections for all streams studied, except Dunlap Creek, were obtained from field surveys and topographic maps at a scale of 1:4800 with a 4-foot contour interval (Reference 6). Cross sections for Dunlap Creek were obtained from aerial photographs taken in December 1979. Maps made from the aerial photographs have a scale of 1:1200 with a 2-foot contour interval (Reference 7).

All bridges were surveyed to obtain data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map.

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TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
STINSON CREEK					
about 1,800 feet downstream of confluence of Smith Branch	24.4	8,100	11,800	13,170	16,800
upstream of confluence of Smith Branch	19.6	5,750	8,600	9,900	12,830
upstream of confluence of Whitlow Branch	18.3	5,510	8,200	9,480	12,350
upstream of Westminster Avenue	17.4	5,340	8,000	9,220	12,040
upstream of confluence of Westminster Branch	16.4	5,090	7,600	8,820	11,550
about 1,400 feet downstream of U.S. Highway 54	15.5	4,940	7,500	8,570	11,240
SMITH BRANCH					
confluence with Stinson Creek	4.7	3,340	5,150	6,000	7,930
400 feet upstream of County Highway O	4.3	3,160	4,900	5,730	7,600
about 2,000 feet upstream of County Highway O	4.2	3,070	4,700	5,590	7,460
about 1,800 feet downstream of Eighth Street	3.6	2,780	4,600	5,080	6,820
upstream of Vine Street	3.3	2,680	4,150	4,870	6,530
at Illinois Central Gulf Railroad	3.0	2,570	3,950	4,680	6,210
about 3,500 feet downstream of Westminster Avenue	2.6	2,310	3,550	4,190	5,580
about 300 feet upstream of Westminster Avenue	1.8	1,850	2,850	3,320	4,470

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TABLE 1 - SUMMARY OF DISCHARGES (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
BIG HOLLOW CREEK					
about 2,200 feet downstream of Cote Sans Dessein Road	2.5	1,130	1,800	2,110	2,920
about 1,500 feet downstream of Cote Sans Dessein Road	2.0	870	1,380	1,610	2,230
at U.S. Business Highway 54	1.8	750	1,200	1,410	1,960
about 1,200 feet downstream of U.S. Highway 54	1.4	520	880	1,070	1,510
WESTMINSTER BRANCH					
just upstream of County Highway F and confluence with Stinson Creek	0.56	970	1,450	1,690	2,240
just upstream of West Seventh Street	0.25	530	800	930	1,230
WHITLOW BRANCH					
about 1,000 feet downstream of Mokane Road	0.48	1,020	1,520	1,760	2,350
about 200 feet upstream of Lee Avenue	0.36	1,060	1,520	1,790	2,320
about 300 feet upstream of Lynn Avenue	0.21	660	960	1,110	1,390
DUNLAP CREEK					
just upstream of Old Harring Mill Road	N/A	559	N/A	1,072	N/A
about 500 feet upstream of Old Harring Mill Road	N/A	414	N/A	780	N/A
about 2,200 feet upstream of Old Harring Mill Road	N/A	161	N/A	315	N/A
about 5,000 feet upstream of Old Harring Mill Road	N/A	106	N/A	206	N/A

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Channel roughness coefficients (Manning's "n") used in the hydraulic computations were assigned on the basis of field inspections of the flood plain areas. The roughness coefficients used for Stinson Creek vary from 0.03 to 0.04 for the channel and 0.04 to 0.07 for the overbank areas. The roughness coefficients used for Smith Branch vary from 0.03 to 0.04 for the channel and 0.03 to 0.06 for the overbank. The roughness coefficients for Big Hollow Creek vary from 0.03 to 0.035 for the channel, whereas the roughness coefficient for the overbank is 0.06. Roughness coefficients used for Westminster Branch are 0.03 for the channel and 0.04 for the overbank areas. Roughness coefficients used for Whitlow Branch vary from 0.035 to 0.04 for the channel and 0.04 to 0.06 for the overbank areas. Roughness coefficients used for Dunlap Creek were 0.05 for the channel and 0.06 for the overbank areas.

The starting elevations of each stream were computed by normal depth calculations. Water-surface elevations for each stream were computed through use of the COE, Kansas City District, water-surface backwater computer program (Reference 8). Water-surface elevations for Dunlap Creek were computed through use of the COE HEC-2 step-backwater computer program (Reference 9).

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations shown on the profiles are, thus, considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to NGVD. Elevation reference marks used in this study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections the boundaries were interpolated using topographic maps at a scale of 1:4800 with a 4-foot contour interval (Reference 6). Approximate areas of flooding were taken from the Type 15 Flood Insurance Study for the City of Fulton (Reference 1).

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The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map. In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 2, Floodway Data. Portions of the floodway of Stinson Creek lie outside the corporate limits. No floodway was determined for Dunlap Creek.

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
SMITH BRANCH								
A	170	60	564	10.6	697.0	697.0	697.8	0.8
B	1224	49	380	15.8	708.6	708.6	709.3	0.7
C	2364	126	693	8.7	717.1	717.1	717.6	0.5
D	2798	135	533	11.3	720.7	720.7	720.7	0.0
E	3414	116	1268	4.7	732.5	732.5	732.5	0.0
F	4158	105	682	8.4	732.8	732.8	732.8	0.0
G	5000	202	754	7.4	735.4	735.4	735.6	0.2
H	5530	139	513	10.9	739.2	739.2	739.5	0.3
I	6330	145	626	8.9	744.9	744.9	745.2	0.3
J	6894	173	602	9.3	747.8	747.8	748.2	0.4
K	7536	114	450	11.3	752.7	752.7	752.7	0.0
L	8426	99	464	10.9	760.0	760.0	760.2	0.2
M	9632	83	405	12.5	767.3	767.3	767.7	0.4
N	10,239	120	458	11.1	771.5	771.5	772.2	0.7
O	10,966	34	301	16.9	779.3	779.3	780.1	0.8
P	11,989	38	312	16.3	789.4	789.4	789.4	0.0
Q	12,792	365	2623	1.9	793.5	793.5	794.3	0.8
R	13,319	210	537	9.1	793.5	793.5	794.3	0.8
S	13,831	213	1746	2.3	796.6	796.6	797.1	0.5
T	14,290	195	885	5.5	796.7	796.7	797.1	0.4
U	14,468	231	1999	2.4	800.1	800.1	800.1	0.0
V	15,000	256	2034	2.4	802.1	802.1	802.2	0.1
W	16,337	455	2038	2.1	806.4	806.4	807.1	0.7
X	17,050	389	1276	3.3	807.0	807.7	807.7	0.7
Y	17,296	218	908	4.6	807.4	807.4	808.0	0.6
Z	18,198	174	768	5.4	810.1	810.1	810.9	0.8

[1] FEET ABOVE MOUTH

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

FLOODWAY DATA

SMITH BRANCH

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
SMITH BRANCH								
AA	18,615	166	734	5.7	811.5	811.5	812.3	0.8
AB	20,180	141	426	9.8	813.3	813.3	813.8	0.5
AC	21,354	181	893	3.7	817.1	817.1	817.7	0.6
AD	22,186	184	800	4.2	818.0	818.0	818.7	0.7
AE	23,571	210	749	4.4	820.3	820.3	821.1	0.8
WESTMINSTER BRANCH								
A	236[2]	45	286	5.9	734.7	732.0[3]	733.0	1.0
B	1812[2]	99	207	8.2	747.6	747.6	747.6	0.0
C	2404[2]	25	131	12.9	760.2	760.2	761.2	1.0
D	3224[2]	43	156	10.8	774.4	774.4	774.4	0.0
E	3807[2]	55	170	10.0	781.5	781.5	782.5	1.0

[1] FEET ABOVE MOUTH
[2] FEET ABOVE CONFLUENCE WITH STINSON CREEK
[3] ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM STINSON CREEK

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

FLOODWAY DATA

SMITH BRANCH - WESTMINSTER BRANCH

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
STINSON CREEK								
A	846	121	1251	10.5	693.8	693.8	694.5	0.7
B	1875	166	1028	9.6	695.8	695.8	696.3	0.5
C	3403	209	1487	6.7	700.5	700.5	701.4	0.9
D	3872	70	597	16.6	702.1	702.1	702.1	0.0
E	4750	177	1396	7.1	707.8	707.8	708.6	0.8
F	5199	132	1111	8.9	708.4	708.4	709.2	0.8
G	6018	180	1567	6.3	710.5	710.5	711.5	1.0
H	6896	309	1927	5.1	711.6	711.6	712.4	0.8
I	7750	66	569	16.7	716.8	716.8	716.8	0.0
J	9002	240	2073	4.6	723.3	723.3	722.6	0.8
K	9750	190	1606	5.9	724.3	724.3	724.2	0.5
L	9942	289	2790	3.4	725.2	725.2	725.3	0.7
M	10,277	142	1172	8.1	725.2	725.2	725.3	0.7
N	11,240	422	3658	2.6	728.0	728.0	728.2	0.4
O	12,119	86	896	10.6	728.0	728.0	728.2	0.4
P	14,030	95	900	10.2	734.3	734.3	734.3	0.0
Q	14,678	165	736	12.0	736.1	736.1	736.1	0.0
R	15,201	69	710	12.4	737.9	737.9	738.6	0.7
S	16,020	385	2335	3.8	743.1	743.1	743.1	0.0
T	17,750	92	709	12.4	749.4	749.4	749.4	0.0
U	18,670	134	1255	7.0	753.0	753.0	753.2	0.2
V	19,432	83	716	12.3	753.2	753.2	753.4	0.2
W	19,650	117	813	10.9	754.5	754.5	754.9	0.4
X	20,000	136	780	11.3	756.2	756.2	756.3	0.1
Y	20,750	60	515	16.6	759.3	759.3	759.5	0.2
Z	21,488	281	2616	3.3	764.4	764.4	765.3	0.9
AA	22,213	315[2]	4521	1.9	770.4	770.4	770.4	0.0

[1]FEET ABOVE CORPORATE LIMITS
[2]THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

FLOODWAY DATA

STINSON CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
BIG HOLLOW CREEK								
A	630	66	199	8.1	782.2	782.2	782.2	0.0
B	1906	359	1382	1.2	788.9	788.9	788.9	0.0
C	2599	37	154	6.9	788.9	788.9	788.9	0.0
D	3649	41	152	7.0	791.7	791.7	792.1	0.4
WHITLOW BRANCH								
A	700[2]	165	582	3.0	717.0	717.0	717.8	0.8
B	1125[2]	32	146	12.1	723.8	723.8	724.4	0.6
C	2186[2]	49	168	10.5	739.5	739.5	739.6	0.1
D	2719[2]	66	185	9.5	751.6	751.6	751.6	0.0
E	3328[2]	24	134	13.3	762.3	762.3	762.9	0.6
F	3852[2]	83	147	7.5	768.0	768.0	768.1	0.1
G	4000[2]	38	114	9.8	773.3	773.3	774.3	1.0
H	4318[2]	31	106	10.5	778.1	778.1	778.9	0.8
I	4600[2]	53	127	8.8	783.2	783.2	783.3	0.1
J	4847[2]	27	101	11.0	788.9	788.9	789.9	1.0
K	5043[2]	60	132	8.4	792.3	792.3	792.7	0.4
L	5292[2]	37	112	9.9	794.2	794.2	794.5	0.3

[1] FEET ABOVE CORPORATE LIMITS
[2] FEET ABOVE MOUTH

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

FLOODWAY DATA

BIG HOLLOW CREEK - WHITLOW BRANCH

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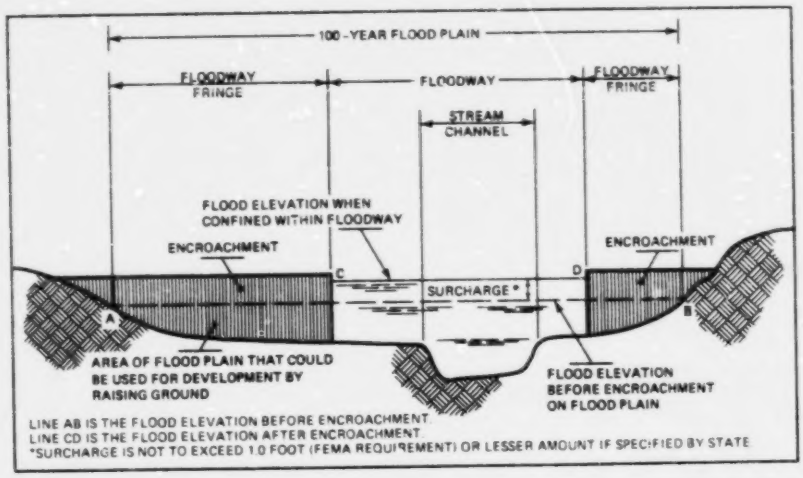
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic

The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Fulton.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the weighted average difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the riverine flooding sources of the City of Fulton are shown on the Flood Profiles and are summarized in Table 3, Flood Insurance Zone Data.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used

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with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the weighted average difference between the 10- and 100-year flood water-surface elevations rounded to the nearest 0.5 foot, multiplied by 10 and shown as a 3-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.
Zones A2-A4, A6:	Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and, areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding source studied in detail in the community are shown in Table 3, Flood Insurance Zone Data.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Fulton is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
STINSON CREEK							
REACH 1	0003,0004,0005	−2.8	−0.9	1.3	030	A6	VARIES–SEE MAP
BIG HOLLOW CREEK							
REACH 1	0005	−2.0	−0.6	1.3	020	A4	VARIES–SEE MAP
WHITLOW BRANCH							
REACH 1	0003,0005	−1.4	−0.5	0.8	015	A3	VARIES–SEE MAP
SMITH BRANCH							
REACH 1	0002,0003,0004	−1.8	−0.8	2.0	020	A4	VARIES–SEE MAP
WESTMINSTER BRANCH							
REACH 1	0005	−1.6	−0.6	1.0	015	A3	VARIES–SEE MAP
DUNLAP CREEK							
REACH 1	0002	−0.9	N/A	N/A	010	A2	VARIES-SEE MAP

[1] FLOOD INSURANCE RATE MAP PANEL
[2] WEIGHTED AVERAGE
[3] ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO

(CALLAWAY CO.)

FLOOD INSURANCE ZONE DATA

STINSON CREEK–BIG HOLLOW CREEK–WHITLOW BRANCH–SMITH BRANCH–WESTMINSTER BRANCH–DUNLAP CREEK

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elevation lines. Base flood elevation lines for riverine flooding sources show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

A Type 15 Flood Insurance Study has been published for the community (Reference 1). The differences between the Type 15 study and this study are justified due to the inclusion of more recent detailed information.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Federal Office Building, Room 300, 911 Walnut Street, Kansas City, Missouri 64106.

8.0 REFERENCES AND BIBLIOGRAPHY

1. Federal Emergency Management Agency, Type 15 Flood Insurance Study, City of Fulton, Callaway County, Missouri, June 1983.

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3. ————, National Oceanic and Atmospheric Administration, National Climatic Center, Annual Summary of Climatological Data for Missouri, Asheville, North Carolina, 1977.

4. U.S. Department of Agriculture, Soil Conservation Service, General Soil Map, Missouri, 1979.

5. U.S. Environmental Protection Agency, Stormwater Management Model, March 1975.

6. U.S. Army Corps of Engineers, Kansas City District, Topographic Maps, Scale 1:4800, Contour Interval 4 feet: Fulton, Missouri, January 1980.

7. M.J. Hardin Associates, Inc., Photogrammetric Engineers, Kansas City, Missouri, Aerial Photographic Map, Scale 1:1200, Contour Interval 2 feet, December 1979.

8. U.S. Army Corps of Engineers, Kansas City District, Water-Surface Backwater Computer Program, December 1977.

9. ————, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles Generalized Computer Program, Davis, California, November 1976.

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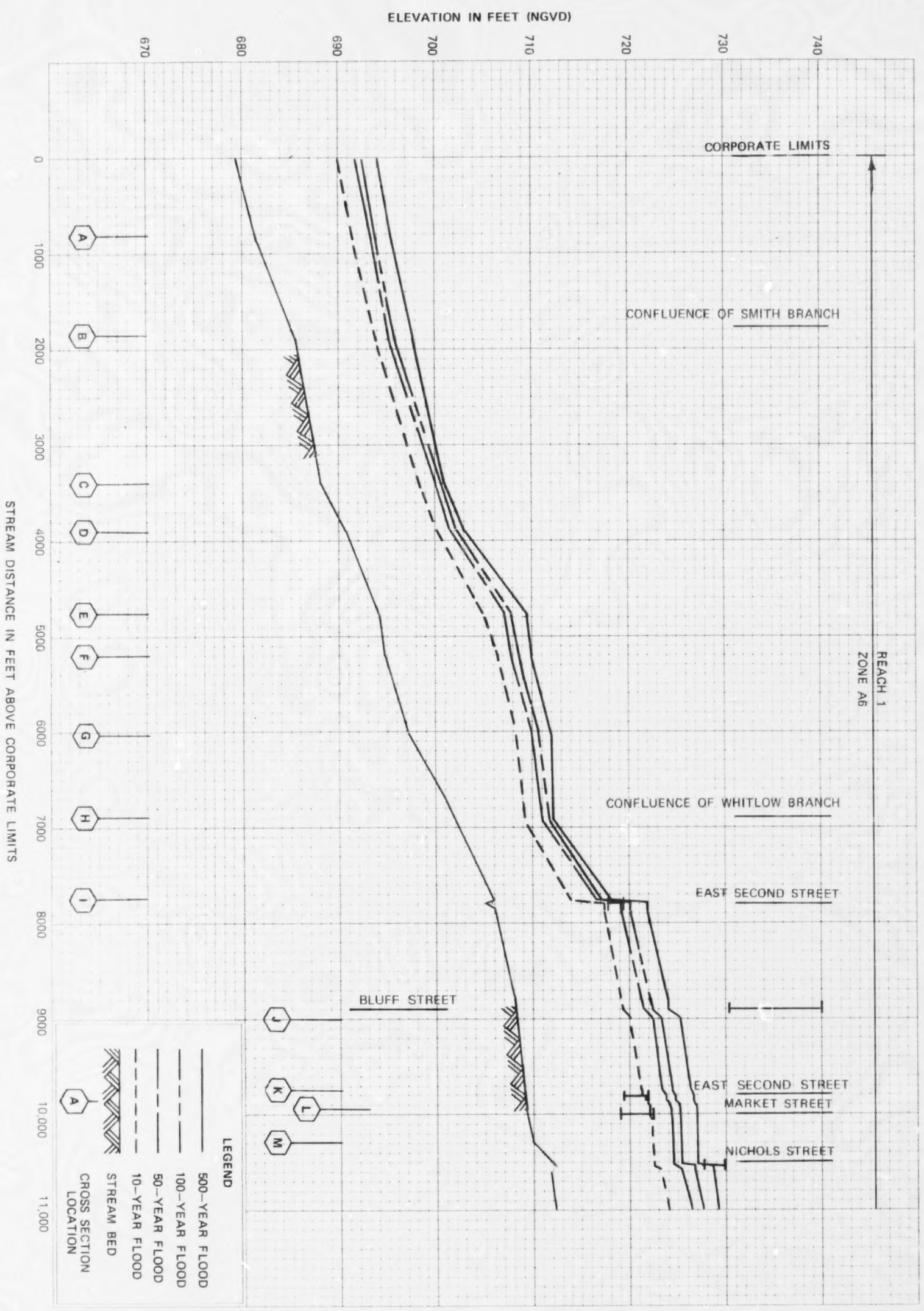

01P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF FULTON, MO** (CALLAWAY CO.)	**FLOOD PROFILES** **STINSON CREEK**

18

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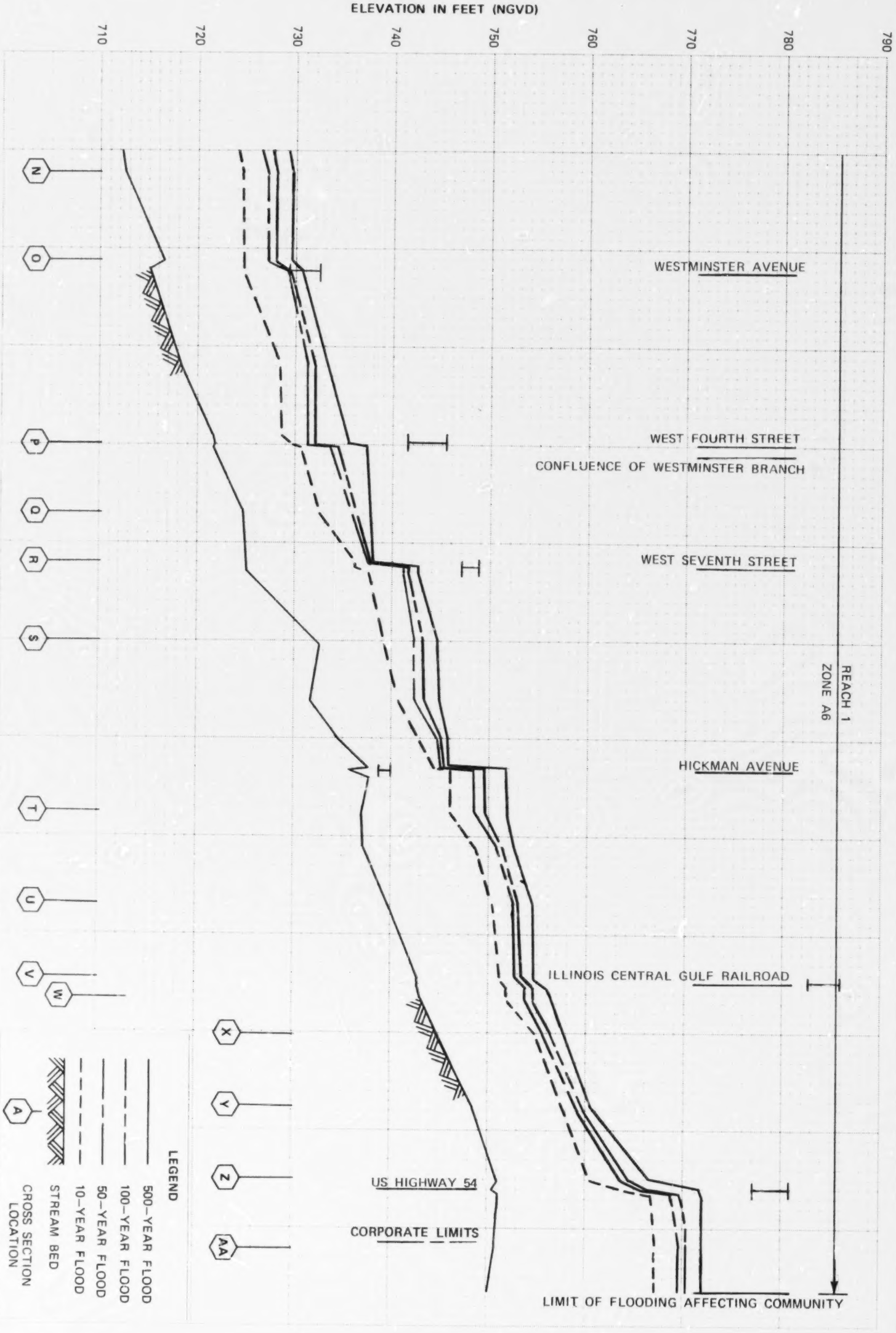

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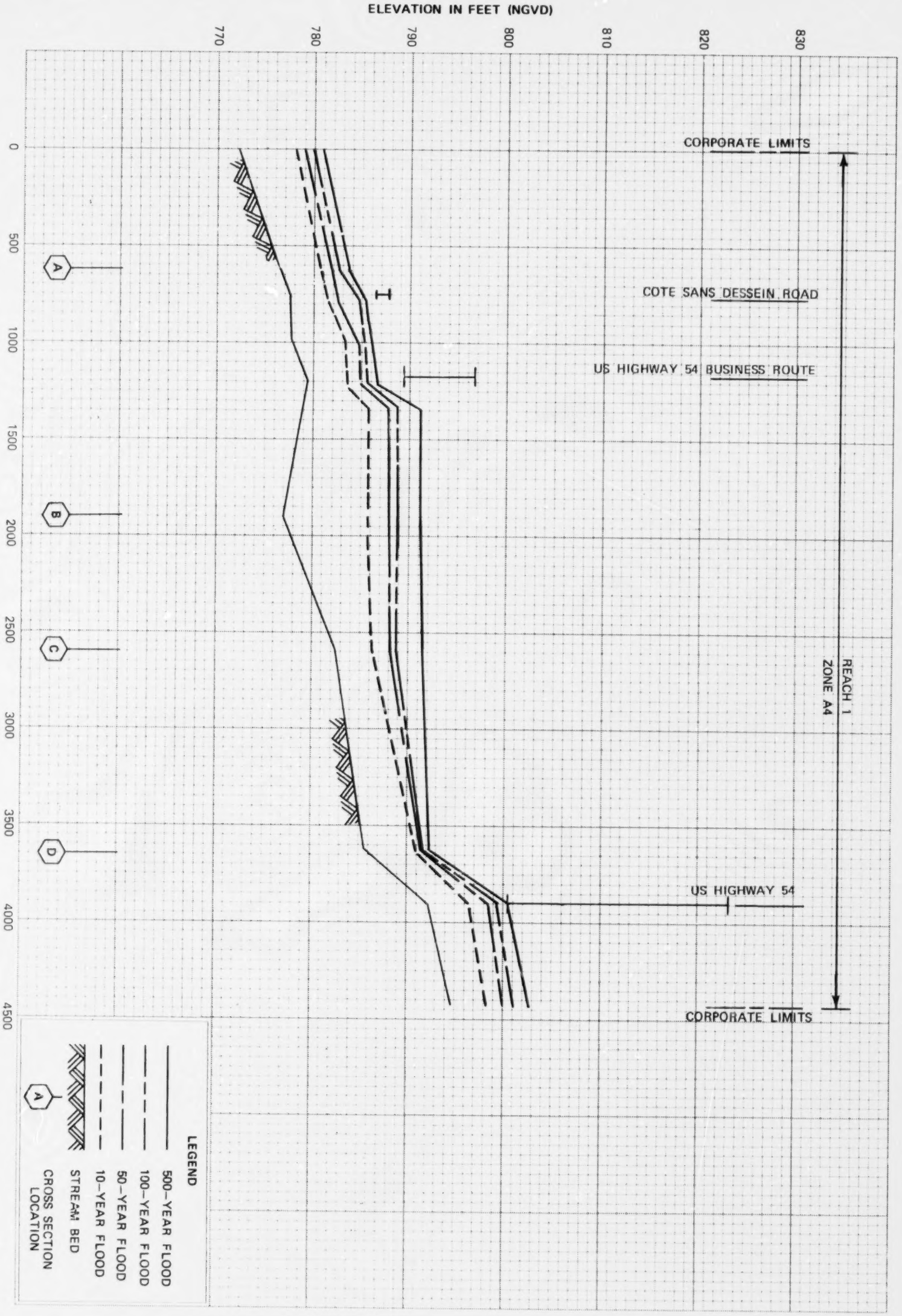

03P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO

(CALLAWAY CO.)

FLOOD PROFILES

BIG HOLLOW CREEK

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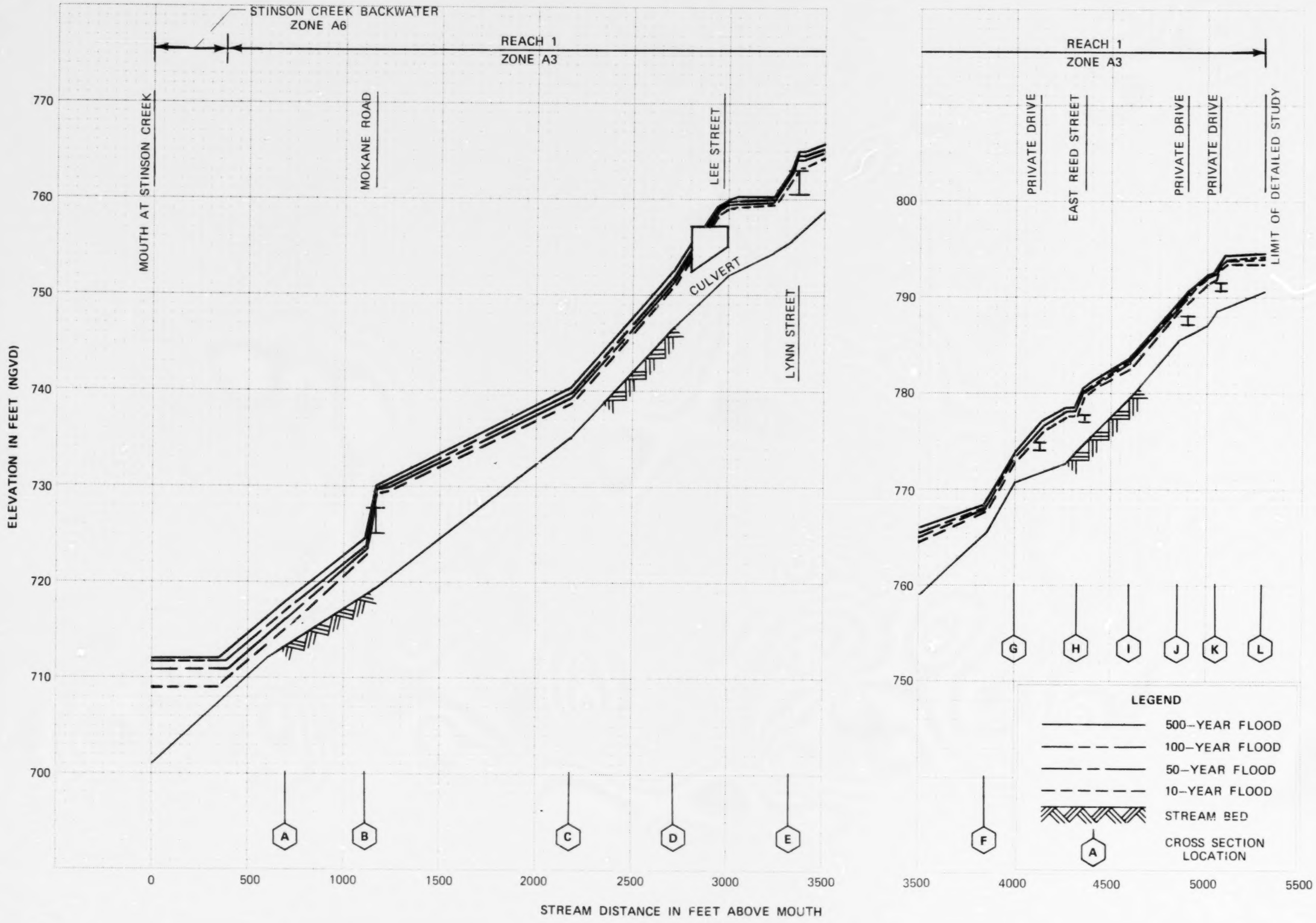

FLOOD PROFILES

WHITLOW BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

04P

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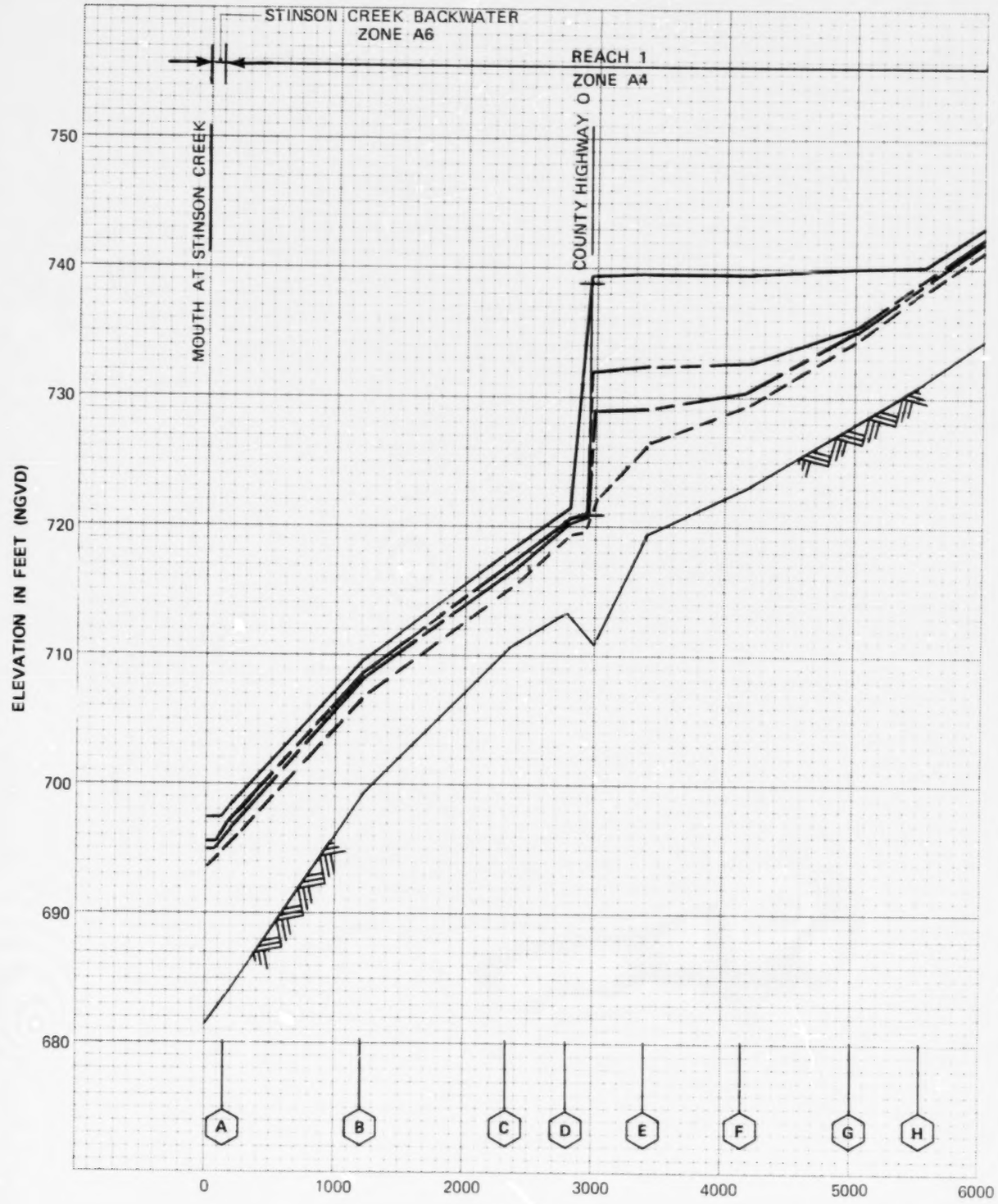

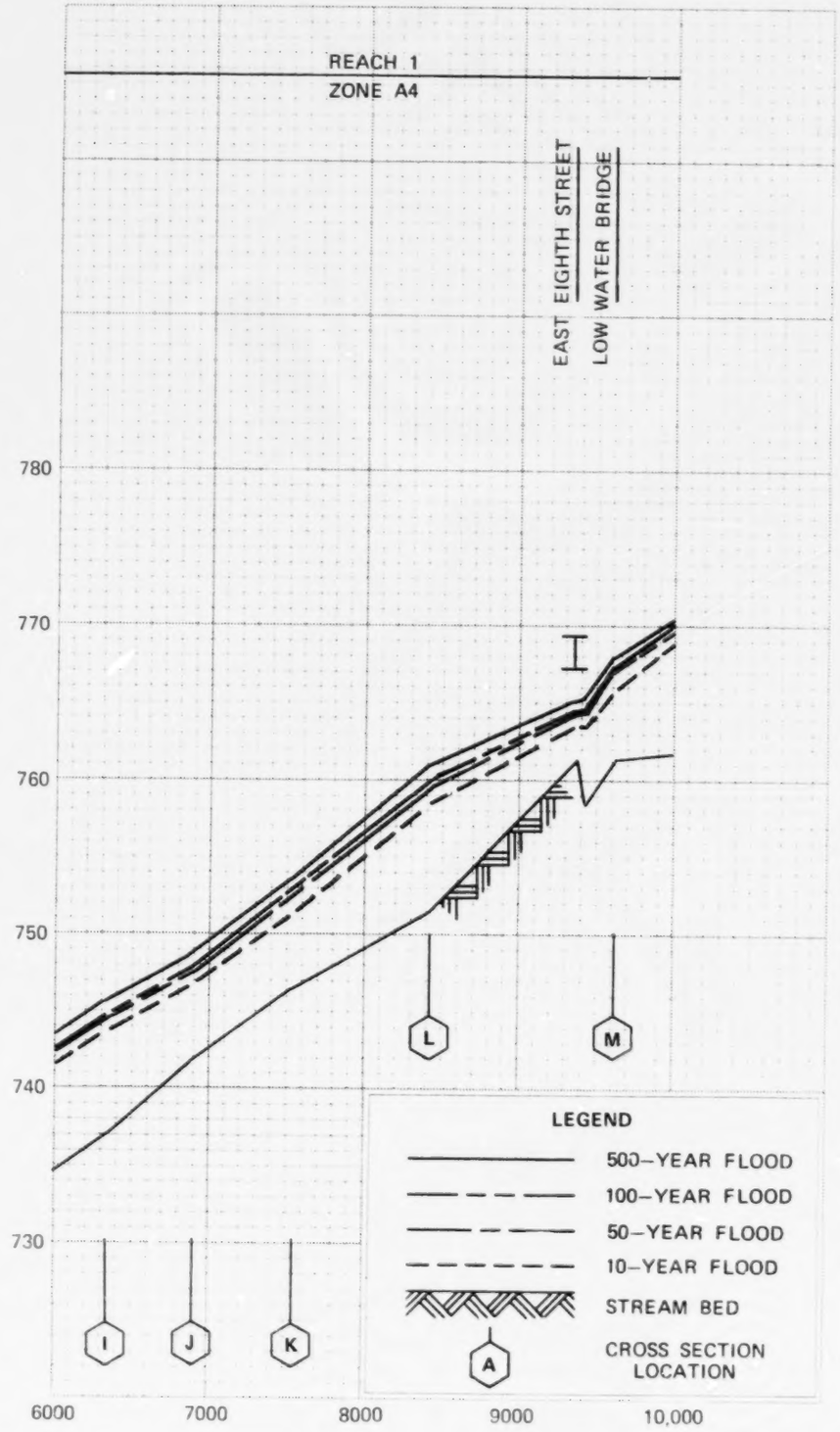

FLOOD PROFILES

SMITH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

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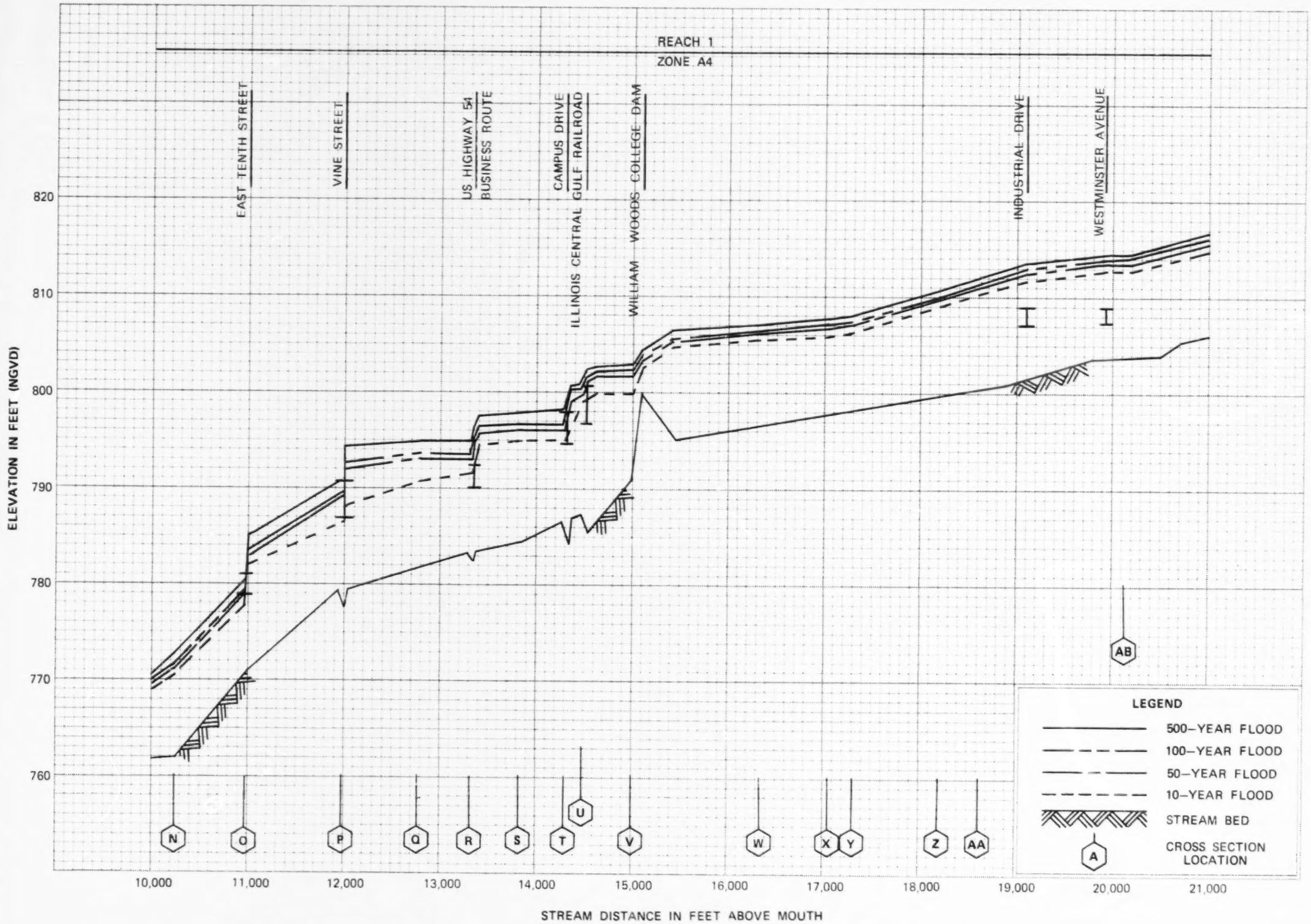

FLOOD PROFILES

SMITH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

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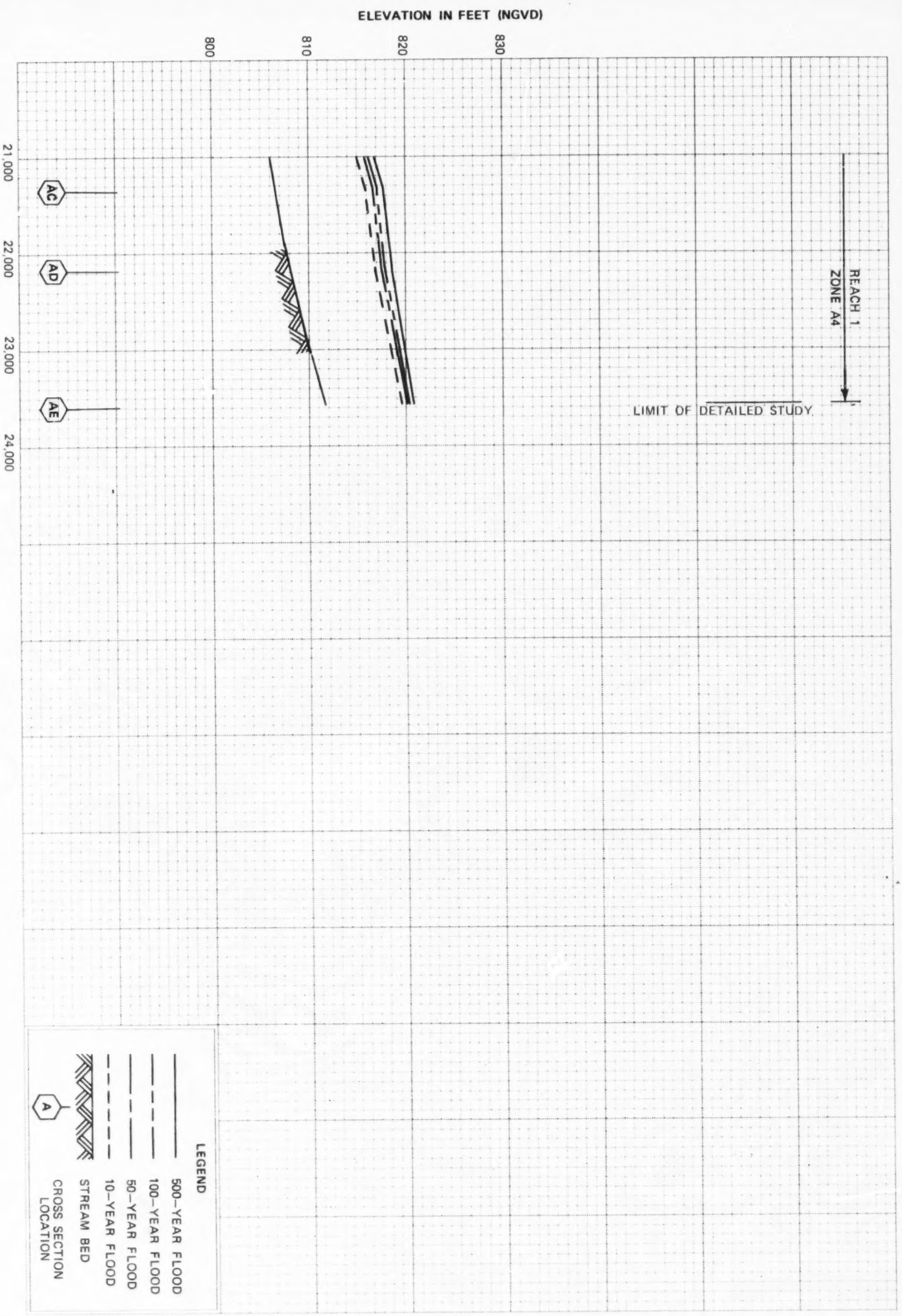

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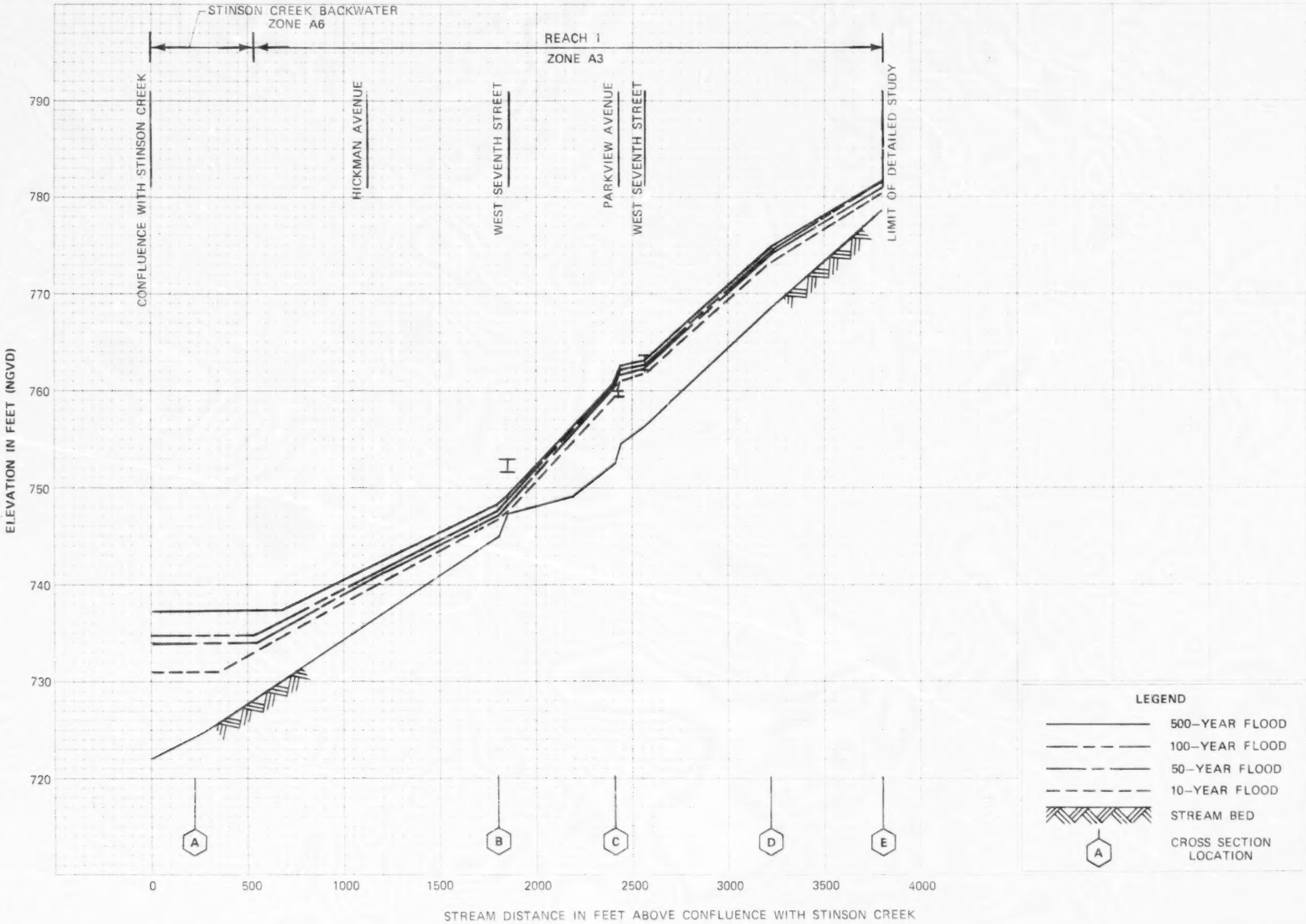

FLOOD PROFILES

WESTMINSTER BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

08P

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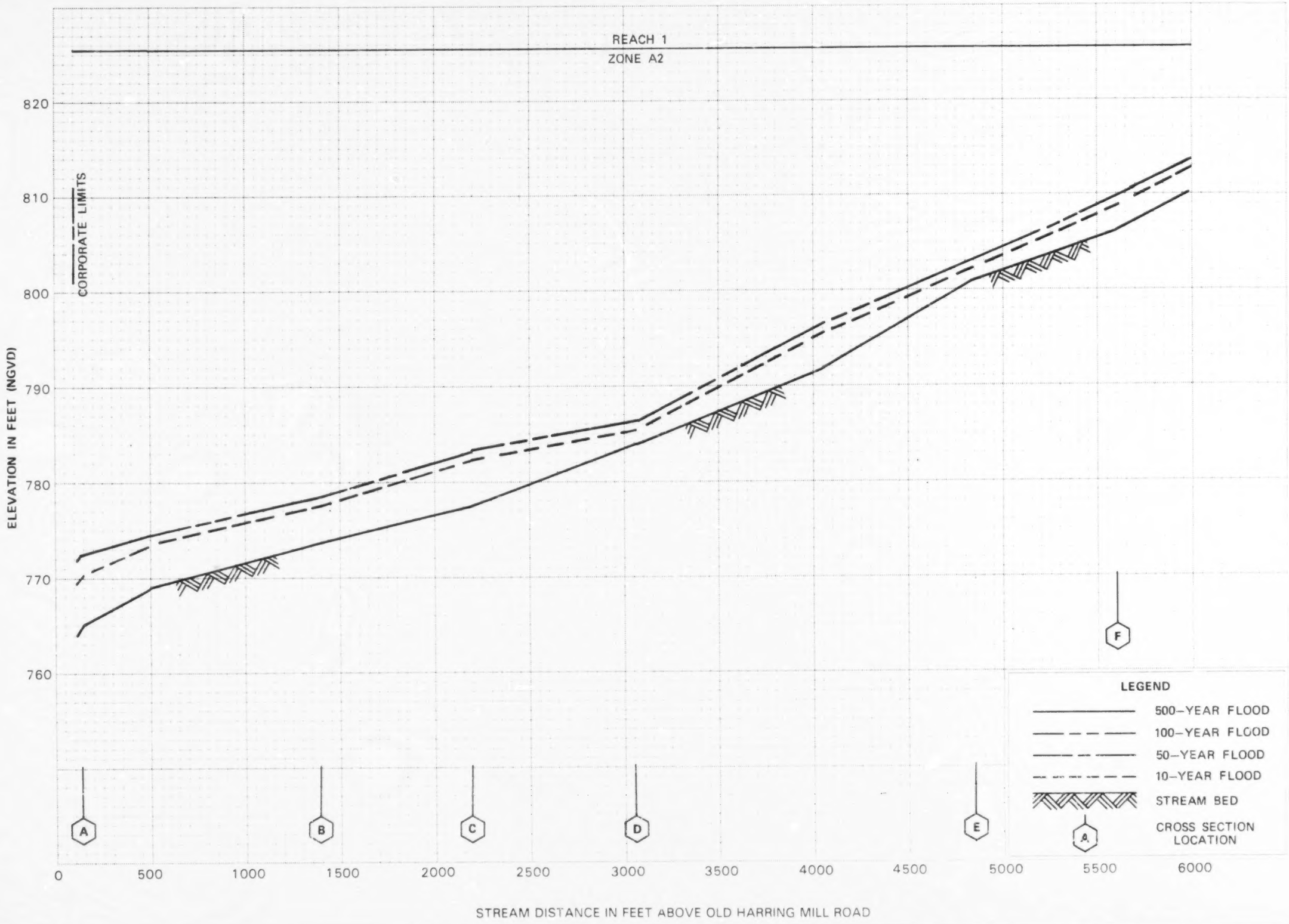

FLOOD PROFILES

DUNLAP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO

(CALLAWAY CO.)

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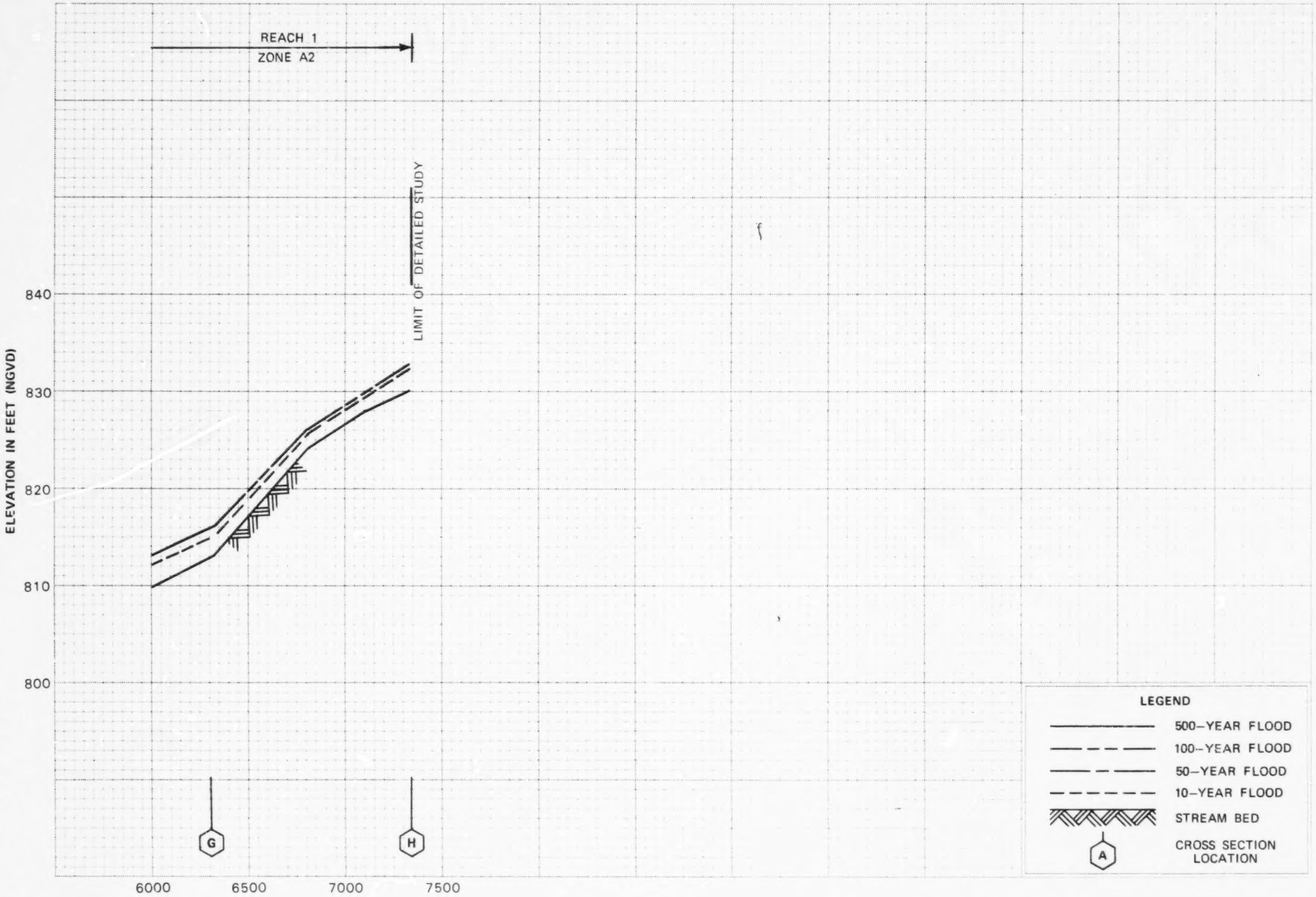

FLOOD PROFILES

DUNLAP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FULTON, MO
(CALLAWAY CO.)

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